PART I - ADMINISTRATIVE

Section 1. General administrative information

Title of project

Redfish Lake Sockeye Salmon Captive Broodstock Program

BPA project number: 9107200
Contract renewal date (mm/yyyy): 6/2001 ☒ **Multiple actions?**

Business name of agency, institution or organization requesting funding
Idaho Department of Fish and Game

Business acronym (if appropriate) IDFG

Proposal contact person or principal investigator:

Name	Paul A. Kline
Mailing Address	1800 Trout Rd.
City, ST Zip	Eagle, ID 83616
Phone	(208) 939-4114
Fax	(208) 939-2415
Email address	pkline@idfg.state.id.us

NPPC Program Measure Number(s) which this project addresses
7.4D Captive Brood Stocks, 7.4E Cryopreservation, 7.5A.1 Snake River Sockeye Salmon

FWS/NMFS Biological Opinion Number(s) which this project addresses
Endangered Species Act recovery effort

Other planning document references
NMFS T.M.# NMFS-NWFSC-2 Pacific Salmon and Artificial Propagation Under the Endangered Species Act. Numerous references to the utility of captive programs in recovery efforts. Reference to the development of comprehensive spawning matrices and the need for milt cryopreservation.

NMFS Pre-decisional Snake River Salmon Recovery Plan - Chapter 3, Numerical Escapement Goals (page 47); Chapter 7, Artificial Propagaton (pages 99-100).

NWPPC Return to the River - Chapter 8, Conclusion #10 under Hatcheries - Identifies hatchery programs for severely depressed stocks important sources of genetic information. Evaluations called for ty the ISG are essential and active components of the IDFG Sockeye Salmon Captive Broodstock Program.

CBFWA FY1999 DraftAnnual Implementation Work Plan - Pages 152-154.

Short description
Establish captive broodstocks of Redfish Lake sockeye salmon. Spawn captive adults to produce eggs, juveniles, and adults for supplementation and future broodstock needs. Monitor nursery lake conditions. Evaluate juvenile outmigration by release option.

Target species
Snake River Sockeye Salmon

Section 2. Sorting and evaluation

Subbasin
Salmon River

Evaluation Process Sort

CBFWA caucus	Special evaluation process	ISRP project type
Mark one or more caucus	If your project fits either of these processes, mark one or both	Mark one or more categories
☒ Anadromous fish ☐ Resident fish ☐ Wildlife	☒ Multi-year (milestone-based evaluation) ☐ Watershed project evaluation	☐ Watershed councils/model watersheds ☐ Information dissemination ☒ Operation & maintenance ☐ New construction ☒ Research & monitoring ☐ Implementation & management ☐ Wildlife habitat acquisitions

Section 3. Relationships to other Bonneville projects

Umbrella / sub-proposal relationships. List umbrella project first.

Project #	Project title/description

Other dependent or critically-related projects

Project #	Project title/description	Nature of relationship
9204000	Redfish Lake Captive Broodstock Rearing and Research	Duplicate broodstock research and rearing by NMFS. Cooperative culture program contributing to the

		development of broodstocks for spawning and for supplementation.
9107100	Snake River Sockeye Salmon Habitat Improvement	Cooperative program by Shoshone-Bannock Tribes. Generates limnology and fish population information critical to overall recovery effort. Active lake fertilization program.
9009300	Genetic Analysis of Oncorhynchus nerka	University of Idaho genetic studies of broodstock and wild sockeye. Generates mtDNA data for program.
8909600	Genetic Monitoring and Evaluation of Snake River Salmon and Steelhead	NMFS genetic studies of broodstock and wild sockeye. Generates allozyme data for program.
9305600	Assessment of Captive Broodstock Technology	NMFS directed captive propagation research. Generates data on a range of subjects relevant to the program.
9700100	Captive Rearing Initiative for Salmon River Chinook Salmon	IDFG captive rearing experiment for Salmon River chinook salmon. Develops rearing protocols relevant to the program. IDFG Eagle Hatchery shares sockeye and chinook rearing responsibilities.

Section 4. Objectives, tasks and schedules

Past accomplishments

Year	Accomplishment	Met biological objectives?
1991	Development of first broodstock from the four anadromous adult returns (BY91 spawning).	Primary spcies conservation objective met.
	First cryopreservation of sockeye milt.	Primary spcies conservation objective met.
	Excellent rearing survival of wild - captured outmigrants transferred to Eagle Hatchery.	Primary spcies conservation objective met.
	Primary facility improvements made to accommodate program at Eagle Hatchery.	
1992	Cryopreservation of milt from the single male anadromous adult return.	Primary spcies conservation objective met.
	First collection of residual sockeye salmon.	Primary spcies conservation objective met.

	Development of a limited residual broodstock (BY92 spawning)	Primary spcies conservation objective met.
1993	Development of broodstocks from the eight anadromous adult returns (BY93 spawning). Maturing outmigrants collected in 1991 incorporated in the spawning matrix.	Primary spcies conservation objective met.
	Cryopreservation of milt from anadromous males and captive outmigrants.	Primary spcies conservation objective met.
	First release of pre-spawn adults (20) in Redfish Lake in September.	Supplementation objective met.
1994	Development of BY94 broodstocks from the single female anadromous adult return and first generation male progeny from BY91.	Primary spcies conservation objective met.
	Development of BY94 supplementation groups using captive outmigrants and first generation progeny from BY91.	Primary spcies conservation objective met.
	First release of pre-smolts (~14,200) to Redfish Lake.	Supplementation objective met.
	Second release of pre-spawn adults (65) in Redfish Lake in September.	Supplementation objective met.
1995	Development of limited broodstocks using wild - captured residual and captive outmigrants (BY95 spawning).	Primary spcies conservation objective met.
	Approximately 85,000 pre-smolts released in Redfish Lake using several supplementation strategies.	Supplementation objective met.
	Approximately 9,000 pre-smolts released in Pettit Lake.	Supplementation objective met.
	Approximately 850 hatchery-produced outmigrants (from 1994 supplementation) successfully overwintered and outmigrated as smolts in 1995.	Outmigration / production objectives met.
	First program smolt release (~3,800) in Redfish Lake Creek.	Supplementation objective met.
	IDFG re-opens Redfish Lake kokanee fishery to help manage kokanee competition.	Critical nursery habitat management objectives met.

1996	Development of BY96 broodstocks from the single female anadromous adult return and first generation male progeny from BY93.	Primary spcies conservation objective met.
	Development of BY96 supplementation groups using first generation progeny from BY93.	Primary spcies conservation objective met.
	First development of safety net broodstock using cryopreserved milt.	Primary spcies conservation objective met.
	Approximately 2,000 pre-smolts released in Redfish Lake.	Supplementation objective met.
	First plant of eyed-eggs (~105,000) in Redfish Lake.	Supplementation objective met.
	Pre-spawn adults (120) released to Redfish Lake with subsequent identification of approximately 30 redds.	Supplementation objective met.
	Approximately 14,900 hatchery-produced outmigrants (from 1995 Redfish and Pettit lake supplementation) successfully overwintered and outmigrated as smolts in 1996.	Outmigration / production objectives met.
	Approximately 11,500 smolts released in Redfish Lake Creek.	Supplementation objective met.
1997	Development of BY97 supplementation groups using first generation progeny from BY94.	Primary spcies conservation objective met.
	Approximately 250,000 pre-smolts released in three lakes.	Supplementation objective met.
	Pre-spawn adults released to Redfish (80), Alturas (20), and Pettit (20) lakes. Redds observed in Redfish and Pettit lakes.	Supplementation objective met.
	Eyed-eggs planted in Redfish (85,000) and Alturas (20,000) lakes.	Supplementation objective met.
	Approximately 400 hatchery-produced outmigrants (from 1996 supplementation) successfully overwintered and outmigrated as smolts in 1997.	Outmigration / production objectives met.
1998	Development of BY98 supplementation groups using first generation progeny from BY96 (females) and BY94 males.	Primary spcies conservation objective met.
	Development of BY98 safety net groups	Primary spcies conservation

	using first generation progeny from BY96 (females), the single 1998 anadromous male return, and cryopreserved milt.	objective met.
	Approximately 142,000 pre-smolts released in three lakes.	Supplementation objective met.
	Approximately 82,000 smolts released in Redfish Lake Creek and the upper Salmon River.	Supplementation objective met.
	Approximately 58,400 hatchery-produced outmigrants (from 1997 supplementation) successfully overwintered and outmigrated as smolts in 1997.	Outmigration / production objectives met.

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1	Develop captive broodstocks from Redfish Lake anadromous sockeye salmon.	a	Develop the technology for captive broodstock propagation to meet program needs.
		b	Trap returning anadromous adults, juvenile outmigrants, and residual sockeye salmon.
		c	Quantify survival, maturation rates, age-at-maturity, sex ratio, and gamete quality of captive sockeye salmon.
		d	Evaluate time held on chilled water (maturing adults) in relation to gamete quality, fertilization rates, and anomalies in broodstock progeny.
		e	Establish spawning matrices in consultation with NMFS and the program technical oversight committee.
		f	Produce genetically defined progeny for use in multiple release strategies to Stanley Basin lakes.
		g	Collect samples for genetic analysis from all wild sockeye salmon incorporated in the program.
		h	Cryopreserve milt from specific wild

			and broodstock sockeye salmon.
		i	Conduct fertilization trials using cryopreserved milt from captive broodstock adults.
		j	Maintain cryopreserved archives at three locations to spread the risk of loss from catastrophic events.
		k	Produce “designer broodstocks” from cryopreserved milt to broaden the genetic base in future brood years.
2	Determine the contribution hatchery-produced sockeye salmon make toward recovery.	a	PIT tag wild Redfish Lake outmigrating smolts and hatchery-produced progeny for evaluation purposes.
		b	Estimate O. nerka outmigration from Stanley Basin lakes.
		c	Evaluate outmigration success by broodstock lineage and release strategy.
		d	Examine travel time to lower Snake River hydropower projects and evaluate survival by broodstock lineage and release strategy.
		e	Identify location, timing, and spawning success for maturing adult broodstock sockeye salmon released to Stanley Basin lakes to spawn volitionally.
3	Describe O. nerka population characteristics for Stanley Basin lakes in relation to carrying capacity and broodstock program supplementation efforts.	a	Estimate O. nerka population variables by mid-water trawl in four Stanley Basin lakes.
		b	Trawl sufficient to estimate abundance and density by age-class.
		c	Collect scale and otolith samples from trawl captures for age and microchemistry analysis. Take tissue samples for genetic analysis. Take stomachs for diet analysis.
		d	Develop lake carrying capacity estimates cooperatively with Shoshone-Bannock Tribes.
		e	Monitor sport fisheries in Redfish Lake to determine their impact on

			recovery efforts (emphasis on kokanee harvest).
4	Refine our ability to discern the origin of wild and broodstock O. nerka to provide maximum effectiveness in their utilization within the broodstock program.	a	Use otolith microchemistry to identify the origin of O. nerka with unknown life histories.
		b	Integrate microchemistry results with genetic information.
5	Technology Transfer	a	Participate in the technical oversight committee process.
		b	Network with technical experts on issues related to culture and broodstock techniques, genetics, pathology and monitoring and evaluations.
		c	Continue efforts to develop a program management plan.
		d	Coordinate public information transfer with project cooperators.
		e	Provide written activity reports to satisfy the needs and requirements of IDFG, the technical oversight committee, NMFS, and BPA.

Objective schedules and costs

Obj #	Start date mm/yyyy	End date mm/yyyy	Measureable biological objective(s)	Milestone	FY2000 Cost %
1	10/1991	9/2000	Primary species conservation objective. Broodstock, rearing, spawning and supplementation.	yes	65.00%
2	4/1991	9/2000	Primary supplementation / production objective. Outmigration monitoring and evaluation data.	yes	20.00%
3	9/1991	9/2000	Primary critical nursery habitat management objective. Annual lake carrying capacity and supplementation	yes	7.00%

			coordination.		
4	10/1991	9/2000	Continuing life history monitoring.		3.00%
5	10/1991	9/2000			5.00%
				Total	100.00%

Schedule constraints
No known constraints.

Completion date
The pre-decisional Snake River Salmon Recovery Plan identifies no end date for conservation programs of this type. Five generations of recovery time following substantive change in survival and adult escapement is suggested.

Section 5. Budget

FY99 project budget (BPA obligated): $680,097

FY2000 budget by line item

Item	**Note**	**% of total**	**FY2000**
Personnel		%32	218,900
Fringe benefits		%11	74,800
Supplies, materials, non-expendable property		%9	62,500
Operations & maintenance		%18	120,183
Capital acquisitions or improvements (e.g. land, buildings, major equip.)		%9	60,000
NEPA costs		%0	0
Construction-related support		%0	0
PIT tags	# of tags: 6,000	%3	17,400
Travel	Includes all costs associated with travel (air & ground transportation, perdiem, lodging).	%3	17,250
Indirect costs	21.3% overhead on Personnel and Operating costs.	%16	109,063
Subcontractor		%0	0
Other		%0	0
		TOTAL BPA FY2000 BUDGET REQUEST	$680,096

Cost sharing

Organization	Item or service provided	% total project cost (incl. BPA)	Amount ($)
		%0	
		%0	
		%0	
		%0	
		Total project cost (including BPA portion)	$680,096

Outyear costs

	FY2001	FY02	FY03	FY04
Total budget	$680,097	$680,000	$680,000	$680,000

Section 6. References

Watershed?	Reference
☐	
☐	Bjornn, T.C., D.R. Craddock, and D.R. Corley. 1968. Migration and survival of Redfish Lake, Idaho, sockeye salmon, Oncorhynchus nerka. Transactions of the American Fisheries Society, 97:360-373.
☐	Bromage, N. R. and R. J. Roberts. 1995. Broodstock Management and Egg and Larval Quality. Blackwell Science Ltd. Cambridge, MA.
☐	Chapman, D.W., W.S. Platts, D. Park, and M. Hill. 1990. Status of Snake River sockeye salmon. Don Chapman Consultants, Inc., Boise, ID.
☐	Cloud, J.G., Miller, W. H. and M.J. Levenduski. 1990. Cryopreservation of sperm as a means to store salmonid germ plasm and to transfer genes from wild fish to hatchery populations. The Progressive Fish Culturist 52:51-53.
☐	Cohen, J. 1989. Statistical power analysis for the behavioral sciences, 2nd ed. Lawrence Erlbaum Associates, Hillsdale, N.J.
☐	Columbia Basin Fish and Wildlife Authority (CBFWA). 1998. Fiscal Year 1998 Draft Annual Implementation Work Plan, Volume 1. Available from Northwest Power Planning Council, Portland, OR.
☐	Columbia River Basin Fish and Wildlife Program (CBFWP). 1994. Northwest Power Planning Council, Portland, OR.
☐	Erdahl, D. A. 1994. Inland Salmonid Broodstock Management Handbook. United States Department of the Interior Fish and Wildlife Service. 712 FW 1.
☐	Everman, B.W. 1895. A preliminary report upon salmon investigations in Idaho in 1894. Bulletin of the United States Fisheries Commission, 15:253-284.
☐	Flagg, T.A. 1993. Redfish Lake sockeye salmon captive broodstock rearing and research, 1991-1992. Report to Bonneville Power Administration, Contract DE-AI79-92BP41841. 16p. Portland, OR.

☐	Flagg, T.A., and W.C. McAuley. 1994. Redfish Lake sockeye salmon captive broodstock rearing and research, 1991-1993. Report to Bonneville Power Administration, Contract DE-AI79-92BP41841. 99p. Portland, OR.
☐	Flagg, T.A., K.A. Johnson, and J.C. Gislason. 1994. Redfish Lake sockeye salmon broodstock programs. In: Proceedings of the 1993 Alaska Department of Fish and Game Sockeye Culture Workshop. Cooper Landing, Alaska.
☐	Flagg, T.A., C.V.W. Mahnken, and K. A. Johnson. 1995. Captive broodstocks for recovery of Snake River sockeye salmon. American Fisheries Society Symposium 15:81-90.
☐	Flagg, T.A., W.C. McAuley, M.R. Wastel, D.A. Frost, and C.V.W. Mahnken. 1996. Redfish Lake sockeye salmon captive broodstock rearing and research, 1991-1994. Report to Bonneville Power Administration, Contract DE-AI79-92BP41841. 98p. Portland, OR.
☐	Fleiss, J.L. 1981. Statistical methods for rates and proportions, 2nd ed. Wiley and Sons, New York, NY.
☐	Hard, J.J., R.P. Jones, M.R. Delarm, and R.S. Waples. 1992. Pacific salmon and artificial propagation under the Endangered Species Act. NOAA (National Oceanic and Atmospheric Admisistration) Technical Memorandum NMFS (National Marine Fisheries Servi
☐	Johnson, K. 1992. Research and recovery of Snake River sockeye salmon. Idaho Department of Fish and Game. Annual Report to U.S. DOE, Bonneville Power Administration, Division of Fish and Wildlife. Project No. 91-72, Contract No. DE-B179-91BP21065.
☐	Johnson, K. 1993. Research and recovery of Snake River sockeye salmon. Idaho Department of Fish and Game. Annual Report to U.S. DOE, Bonneville Power Administration, Division of Fish and Wildlife. Project No. 91-72, Contract No. DE-B179-91BP21065.
☐	Johnson, K. and J. Pravecek. 1995. Research and recovery of Snake River sockeye salmon. Idaho Department of Fish and Game. Annual Report to U.S. DOE, Bonneville Power Administration, Division of Fish and Wildlife. No. 91-72, DE-B179-91BP21065.
☐	Johnson, K. and J. Pravecek. 1996. Research and recovery of Snake River sockeye salmon. Idaho Department of Fish and Game. Annual Report to U.S. DOE, Bonneville Power Administration, Division of Fish and Wildlife. No. 91-72, DE-B179-91BP21065.
☐	Kalish, J.M. 1990. Use of otolith microchemistry to distinguish the progeny of sympatric anadromous and non-anadromous salmonids. Fishery Bulletin, 88: 657-666
☐	Kline, P.A. 1994. Research and recovery of Snake River sockeye salmon. Idaho Department of Fish and Game. Annual Report to U.S. DOE, Bonneville Power Administration, Division of Fish and Wildlife. Project No. 91-72, Contract No. DE-BI79-91BP21065.
☐	Kline, P.A., and J. Younk. 1995. Research and recovery of Snake River sockeye salmon. Idaho Department of Fish and Game. Annual Report to U.S. DOE, Bonneville Power Administration, Division of Fish and Wildlife.

	No. 91-72, DE-BI79-91BP21065.
☐	Kline, P.A., and J.A. Lamansky. 1997. Research and recovery of Snake River sockeye salmon. Idaho Department of Fish and Game. Annual Report to U.S. DOE, Bonneville Power Administration, Division of Fish and Wildlife. No. 91-72, DE-BI79-91BP21065.
☐	Leitritz, E. And R.C. Lewis. 1976. Trout and salmon culture (hatchery methods). California Department of Fish and Game Fish Bulletin 164.
☐	McArthur, T. 1992. Statewide angler opinion and harvest surveys, creel census system. Idaho Department of Fish and Game, Job Performance Report, Project No. F-71-R-14, Subproject 1, Study 1. Boise, ID
☐	McDaniel, T.R., K.M. Prett, T.R. Meyers, T.D. Ellison, J.E. Follett, and J.A. Burke. 1994. Alaska Sockeye Salmon Culture Manual. Special Fisheries Report No. 6. Alaska Department of Fish and Game, Juneau.
☐	Pennell, W. and B.A. Barton. 1996. Principles of Salmonid Aquaculture. Elsevier Science B.V. Amsterdam, The Netherlands.
☐	Piper, G. R., I. B. McElwain, L.E. Orme, J. P. McCraren, L. G. Gowler, and J. R. Leonard. 1982. Fish Hatchery Management. U.S. Fish and Wildlife Service, Washington, D.C.
☐	Pravecek, J.J. and K.A. Johnson. 1997. Research and recovery of Snake River sockeye salmon. Idaho Department of Fish and Game. Annual Report to U.S. DOE, Bonneville Power Administration, Division of Fish and Wildlife. No. 91-72, DE-B179-91BP21065.
☐	Rieman, B.E. 1992. Kokanee salmon population dynamics - kokanee salmon monitoring guidelines. Idaho Department of Fish and Game, Project No. F-73-R-14, Subproject II, Study II. Boise, ID.
☐	Rieman, B.E., D.L. Myers, and R.L. Nielsen. 1993. The use of otolith microchemistry to discriminate Oncorhynchus nerka of resident and anadromous origin. Idaho Department of Fish and Game. Boise, ID.
☐	Schiewe, M.H., T.A. Flagg, and B.A. Berejikian. 1997. The use of captive broodstocks for gene conservation of salmon in the western United States. Bull. Natl. Res. Inst. Aquacult., suppl. 3:29-34.
☐	Schmitten, R., W. Stelle, Jr., and R. P. Jones. 1997. Draft Proposed Recovery Plan for Snake River Salmon. National Marine Fisheries Service, Portland, OR.
☐	Sokal, R.R., and F.J. Rohlf. 1981. Biometry, 2nd ed. W.H. Freeman and Company, New York, NY.
☐	Spaulding, S. 1993. Snake River sockeye salmon (Oncorhynchus nerka) habitat/limnological research, 1992. Report of research to BPA, Contract DE-BI79-91BP22548. Portland, OR.
☐	Taki, D. and A. Mikkelsen. 1997. Snake River sockeye salmon habitat and limnological research, 1996. Report to Bonneville Power Administration, Contract DE-BI79-91BP22548. Portland, OR.
☐	Teuscher, D., D. Taki, W.A. Wurtsbaugh, C. Luke, P. Budy, H.P. Gross and G. Steinhart. 1994. Snake River sockeye salmon habitat and limnological research, 1993. Report to Bonneville Power Administration, Contract DE-BI79-91BP22548. Portland, OR.

☐	Teuscher, D., D. Taki, W.A. Wurtsbaugh, C. Luke, P. Budy, and G. Steinhart. 1995. Snake River sockeye salmon habitat and limnological research, 1994. Report to Bonneville Power Administration, Contract DE-BI79-91BP22548. Portland, OR.
☐	Teuscher, D., and D. Taki. 1996. Snake River sockeye salmon habitat and limnological research, 1995. Report to Bonneville Power Administration, Contract DE-BI79-91BP22548. Portland, OR.
☐	Toole, C.L., and R.L. Nielsen. 1992. Effects of microprobe presicion on hypotheses related to otolith Sr:Ca ratios. Fishery Bulletin 41:239-255.
☐	Waples, R.S. 1991. Definition of species under the Endangered Species Act: application to Pacific salmon. NOAA (National Oceanic and Atmospheric Administration) Technical Memorandum NMFS (National Marine Fisheries Service F/NWC-194.
☐	Wheeler, P. A. , and G. A. Thorgaard. 1991. Cryopreservation of rainbow trout semen in large straws. Aquaculture 93:95-100.
☐	Zar, J.H. 1974. Biostatistical Analysis. 1974. Prentice-Hall, Inc., Englewood Cliffs, NJ.
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PART II - NARRATIVE

Section 7. Abstract

Precipitous declines of Snake River sockeye salmon lead to their Federal listing as endangered in 1991 (Redfish Lake ESU). In that same year, the Idaho Department of Fish and Game initiated a Captive Broodstock Program to maintain Snake River sockeye salmon and prevent species extinction. Ultimately, our goal is to reestablish sockeye salmon runs to Stanley Basin waters and to provide for sport and treaty harvest opportunity. Without the boost provided by this program, it is virtually certain that Redfish Lake sockeye salmon would be extinct. Captive broodstock efforts are consistent with the Recovery Goal presented in Chapter 7 of the National Marine Fisheries Service (NMFS) pre-decisional Snake River Salmon Recovery Plan and with the Power Planning Council's Columbia River Basin Fish and Wildlife Program (7.4D, 7.4E, 7.5A.1).

Since the inception of the program in 1991, all returning anadromous adult sockeye salmon (16 fish), several hundred Redfish Lake wild outmigrants, and several residual sockeye salmon adults have been captured and used to establish captive broodstocks at the IDFG Eagle Fish Hatchery and at NMFS facilities in Washington State. Adaptively managed, the program generates hatchery-produced eggs, juveniles, and adults for supplementation to Stanley Basin waters. In addition, emphasis is placed

on the continued development of genetically diverse “safety net” broodstocks. Program captive broodstock techniques reflect the Regions best protocols for maintaining maximum genetic diversity, survival, and production success. Fish culture variables including broodstock lineage, survival to maturation, fecundity, egg survival to eye, and fish health are continuously monitored and evaluated to insure maximum program success. Juvenile outmigrant monitoring (using PIT tag technology) and adult sonic telemetry studies provide information critical for the evaluation of program supplementation strategies. Program methods and results undergo constant review through the Stanley Basin Sockeye Technical Oversight Committee (SBSTOC) process.

To date, approximately 160,000 hatchery-produced juvenile sockeye salmon have emigrated from Stanley Basin nursery waters. To balance natural escapement and hatchery production goals, a management plan is being prepared by SBSTOC participants. The program is expected to continue until successful natural spawning is established at sustainable levels adequate to achieve NMFS delisting criteria.

Section 8. Project description

a. Technical and/or scientific background

Numbers of Snake River sockeye salmon have declined dramatically in recent years. In Idaho, only the lakes of the upper Salmon River (Stanley Basin) remain as potential sources of production. Historically, five Stanley Basin lakes (Redfish, Alturas, Pettit, Stanley, and Yellow Belly) supported sockeye salmon (Bjornn et al. 1968; Chapman et al. 1990). Currently, only Redfish Lake receives a remnant anadromous run (Kline 1994; Kline and Younk 1995; Kline and Lamansky 1997). Historical accounts of sockeye salmon abundance in the Stanley Basin are scarce. In the late 1800's Everman (1895) made observations on the distribution and abundance of sockeye salmon in Stanley Basin lakes. Although not quantitatively described, Everman reported observing sockeye salmon in Alturas, Pettit, and Stanley lakes. Between 1954 and 1966, a two-way weir was operated by IDFG on Redfish Lake Creek (Bjornn et al. 1968). During these years, adult sockeye salmon escapement ranged from a low of 11 fish in 1961 to a high of 4,361 fish in 1955. By 1962, sockeye salmon were no longer returning to Stanley, Pettit, and Yellow Belly lakes (Chapman et al. 1990). IDFG personnel operated the adult weir on Redfish Lake Creek between 1985 and 1987. In those years, 11, 29, and 14 adults were counted. Since the inception of recovery efforts in 1991, only 16 adult sockeye salmon have returned to Redfish Lake Creek.

Waples (1991), described Snake River sockeye salmon as a prime example of a species on the threshold of extinction. In December 1991, NMFS listed Snake River sockeye salmon as Endangered under the Endangered Species Act (ESA). The ESA recognizes that conservation of listed species may be facilitated by artificial means while factors impeding population recovery persist (Hard et al. 1992). Often, the only reasonable avenue to build populations quickly enough to avoid extinction is through captive broodstock technology (Flagg et al. 1995). Based on critically low population numbers and the risk of extinction, IDFG in cooperation with NMFS, the Shoshone-Bannock Tribes, Bonneville Power Administration, and others initiated recovery efforts in 1991 (Johnson 1992; Flagg 1993; Johnson 1993; Spaulding 1993; Flagg and McAuley

1994; Flagg et al. 1994; Kline 1994; Teuscher et al. 1994; Flagg et al. 1995; Johnson and Pravecek 1995, 1996; Kline and Younk 1995; Teuscher et al. 1995; Flagg et al. 1996; Teuscher and Taki 1996; Kline and Lamansky 1997; Pravecek and Johnson 1997; Taki and Mikkelsen 1997). Consistent with the Council's Fish and Wildlife Program (CBFWP 1994), the NMFS 1997 pre-decisional Snake River Salmon Recovery Plan (Schmitten et al. 1997), and the Columbia Basin Fish and Wildlife Authority (CBFWA) fiscal year 1999 draft annual implementation work plan (CBFWA 1998), these efforts focus on protecting and rebuilding the last known remnants of the population.

Although not without risk, captive broodstock technology is sufficiently advanced to provide the measures necessary to amplify depressed populations and reduce extinction risk (Flagg et al. 1995; Schiewe et al. 1997). For Redfish lake sockeye salmon, captive techniques may represent the only means of rebuilding population strength and genetic variability quickly enough to avoid the consequences of genetic bottlenecks, drift, inbreeding and possible population extinction.

Coordination of recovery efforts is carried out under the guidance of the Stanley Basin Technical Oversight Committee (SBSTOC), a team of technical experts representing the agencies involved in the recovery and management of Snake River sockeye salmon. Further coordination takes place at the Federal level through the ESA Section 10 permitting process.

b. Rationale and significance to Regional Programs

Rational for the project: Numbers of Snake River sockeye salmon have declined dramatically in recent years. In Idaho, only the lakes of the upper Salmon River (Stanley Basin) remain as potential sources of production. In response to a 1990 petition from the Shoshone-Bannock Tribes, NMFS declared the Redfish Lake population "Endangered" in November, 1991. Since 1991, only 16 adult sockeye have returned to Redfish Lake.

IDFG program goals and objectives are consistent with the Council's Fish and Wildlife Prigram (FWP) and focus on issues specifically addressed in the following sections of the plan: 1)7.4D - the Council identifies captive brood stocks as "the most cost effective means of accelerating recovery of severely depleted stocks" and 2)7.5A.1 - the Council recommends sockeye salmon captive broodstock efforts for funding and lists recommendations including the maintenance of captive broodstocks for the production of supplementation progeny and the development of a program of monitoring and evaluation as the basis for making program improvements. In fact, IDFG Captive Broodstock Program objectives specifically address all "features" of section 7.5A. In many cases, specific broodstock program objectives transcend the Council's FWP. Examples include: the development of "desirable" future broodstocks using cryopreserved milt, and the evaluation of outmigrant success by broodstock lineage and release strategy. Captive broodstock efforts are also consistent with the Recovery Goal presented in Chapter 7 of the NMFS pre-decisional snake river Salmon recovery Plan (Schmitten et al. 1997). In addition, IDFG sockeye recovery efforts conform with recommendations developed by CBFWA Basin co-managers. Specifically, the use of captive broodstock technology to increase numbers of Redfish Lake sockeye salmon is identified as one of several general strategies developed to achieve outcome-based objectives identified in the 1999 Draft Annual Implementation Work Plan (CBFWA 1998).

To further insure that FWP goals are met, IDFG efforts are coordinated with the NMFS, University, and Tribal programs (see Section 8.c. below). Coordination of program efforts is carried out under the guidance of the Stanley Basin Technical Oversight Committee (SBSTOC). The project mitigates losses in place and in kind.

c. Relationships to other projects

Captive broodstock activities conducted by NMFS at Washington State locations (BPA Project 9204000) are an integral component of the overall recovery effort. Eggs produced from anadromous adults at the IDFG Eagle Fish Hatchery are divided equally between IDFG and NMFS facilities. Duplicate broodstocks are maintained at both locations to guard against catastrophic loss. Eggs, juveniles, and adults produced at NMFS facilities are transferred to Idaho waters for supplementation. Annual supplementation strategies rely on production from both IDFG and NMFS culture facilities.

Captive broodstock research conducted by NMFS (BPA Project 9305600) provides technology that contributes to improving program success. Specific areas of research critical to the program include: reproductive behavior, gamete quality, fish health, and the genetic and behavioral consequences of inbreeding.

Habitat investigations of Stanley Basin lakes conducted by the Shoshone-Bannock Tribes (BPA Project 9107100) provide the foundation from which supplementation efforts are based. Base line fishery and limnology data are used to develop whole lake fertilization programs for Redfish, Alturas, and Pettit lakes. Fertilization programs provide richer nursery conditions, improve over winter fish survival and outmigration success, and help stabilize the variability in natural production frequently observed in oligotrophic lakes.

Genetic investigations of Idaho and regional O. nerka populations by the University of Idaho (BPA Project 9009300) and NMFS (BPA Project 8909600) provide information essential to the development of anadromous, not resident, broodstocks and how local populations “fit in” regionally. This was particularly critical between 1991 and 1993 when wild smolts were taken into the program to build future broodstocks. Genetic information continues to be used to identify; indigenous and introduced lake populations, the proportion of residual to resident fish sampled during trawl surveys and sport fisheries, and the origin of returning anadromous adults.

IDFG fish propagation activities associated with the sockeye captive broodstock program (BPA Project 9107200) and the chinook salmon captive rearing program (BPA Project 9700100) are both conducted at the Eagle Fish Hatchery. Although managed as separate projects, program responsibilities overlap and complement each other.

d. Project history (for ongoing projects)

Project Number - BPA Project 9207000 (unchanged)
Project Reports and Papers- Relevant “in house” reports and papers include: Johnson 1992, 1993; Flagg et al. 1994; Kline 1994; Flagg et al. 1995; Johnson and Pravecek 1995,

1996; Kline and Younk 1995; Siri and Johnson 1995; Kline and Lamansky 1997; and Pravecek and Johnson 1997. Full citations are listed in Section 6 of this application.
Past Costs -
FY 1992- $529,673; FY 1993- $663,485; FY 1994- $744,088; FY 1995- $654,899; FY 1996- $618,447; FY 1997- $618,447; FY 1998- $700,000, FY 1999- $680,097

History and Results

The IDFG initiated captive broodstock and research efforts in 1991. Fish culture responsibilities are shared with NMFS at two Washington State locations. Broodstocks have been established from returning anadromous adults (1991, 1992, 1993, 1994, 1996, and 1998), wild outmigrants (1991 - 1993, 1995), and residual sockeye salmon (1992, 1993, 1995). Maturation in adult broodtsocks has occurred primarily at age 3. Egg survival to eye has ranged from 0% to 99% (by individual female) with overall eye-up averaging approximately 60%. Survival of broodstocks in the hatchery has been excellent (approximately 80% from hatch to spawning). To date, IDFG and NMFS culture facilities have produced approximately 800,000 eyed-eggs for supplementation and future broodstock needs.

Review of Supplementation

The first releases of hatchery-produced juvenile sockeye salmon to Redfish Lake occurred in 1994. Two release strategies were used with four broodstock lineages represented. All juvenile sockeye salmon produced for supplementation in 1994 (14,119) were planted in Redfish Lake as age 0+ pre-smolts. The majority of 1994 supplementation fish (11,130) were released to lake net pens in mid-October with the balance (2,989) being released directly to the lake in late November.

In 1995, 95,411 hatchery-produced sockeye salmon (brood year 1994) were planted to Stanley Basin waters over five release strategies. Compared to 1994 efforts, 1995 supplementation incorporated the release of additional pre-smolt lineage groups and release strategies in Redfish Lake (83,045), a yearling smolt release to Redfish Lake Creek (3,794), and a direct release of age 0+ pre-smolts to Pettit Lake (8,572).

In 1996, 1,895 age 0+ pre-smolts were planted in Redfish Lake net pens. In addition, 11,545 age 1+ smolts were released directly in Redfish Lake Creek in May. Age 0+ sockeye salmon released in 1996 were progeny of Redfish Lake residual sockeye salmon and lake outmigrants. Age 1+ smolts were second generation progeny of the four anadromous sockeye salmon that returned to Redfish Lake Creek in 1991. Smolts were produced from broodstock that matured at the NMFS Big Beef Creek facility in Washington State. Rearing occurred at Oregon Department of Fish and Wildlife's Bonneville Fish Hatchery. In November of 1996, approximately 105,000 eyed-eggs were introduced to incubation boxes in Redfish Lake. This was the first year this strategy was employed.

In 1997, brood year 1996 pre-smolts were released to Redfish (153,022), Pettit (8,643), and Alturas (94,746) lakes. Direct lake releases conducted in July and October accounted for 60% of the total number of fish introduced to Redfish Lake. The remaining 40% were released to the lake after three months of net pen rearing. Only direct lake releases were made in Pettit (July) and Alturas (July and October) lakes. In 1997, two broodstock lineages were represented with the majority of fish being second generation progeny of the eight anadromous adult sockeye salmon that returned to

Redfish Lake Creek in 1993. In November of 1997, approximately 85,000 and 20,000 eyed-eggs were introduced to incubation boxes in Redfish and Alturas lakes, respectively. No smolt releases were made in 1997.

In 1998, brood year 1997 pre-smolts were released to Redfish (95,248), Alturas (39,377), and Pettit (7,269) lakes. The net pen rearing strategy accommodated 58% of the total number of pre-smolts released to Redfish Lake. The balance of fish were released directly to Redfish Lake in the fall. Alturas and Pettit lake groups were released directly to lakes in the fall. Brood year 1997 pre-smolts were second generation progeny of the single female sockeye that returned to Redfish Lake in 1994. In addition to pre-smolt releases, 81,615 yearling smolts were released in May of 1998 between Redfish Lake Creek and the upper Salmon River at the Sawtooth Hatchery weir. No eyed-egg plants were made in 1998.

Pre-spawn adult sockeye salmon from the captive broodstock program were first released to Stanley Basin waters in 1993. In that year 20 maturing, adult broodstock sockeye salmon were released to Redfish Lake to naturally spawn. In 1994, 65 maturing adults were released to Redfish Lake. No adults were released in 1995. Telemetry observations identified only one incidence of spawning related behavior for release years 1993 and 1994. In September of 1996, 120 maturing broodstock adults were released to Redfish Lake. During the course of telemetry investigations, we identified approximately 30 redds near the Sawtooth National Recreation Area Transfer Camp Dock at the south-west end of the lake. In 1997, the adult release program was expanded to include Pettit and Alturas lakes. In that year, 80, 20, and 20 adult sockeye salmon were released to Redfish, Pettit, and Alturas lakes, respectively. Telemetry investigations identified suspected test digs in Alturas Lake and only one well developed redd in Pettit Lake. However, approximately 30 well developed redds were once again observed at the south end of Redfish Lake. No releases of pre-spawn adults were made in 1998.

Wild and Hatchery-Generated Smolt Outmigration

Estimated wild, smolt outmigration from Redfish Lake has ranged from a high of 4,500 fish in 1991 to a low of 357 fish in 1995. In five of the eight years investigated, wild smolt outmigration was estimated at fewer than 1,000 fish. As no anadromous adults have spawned in Redfish Lake since 1989, wild outmigrants (since 1992) are considered progeny of the beach-spawning residual component of the ESU. In 1998, wild smolt (adipose fin intact) outmigration from Redfish Lake was estimated at 3,000 fish. Based on residual sockeye salmon spawning surveys and recent residual-produced wild outmigrant numbers, the majority of 1998 wild outmigrants were presumably produced from 1996 program eyed-egg plants and 1998 pre-spawn adult releases.

Hatchery-produced smolts first outmigrated from Redfish Lake in 1995. In that year, we estimated 823 hatchery smolts outmigrated past the juvenile trapping facility on Redfish Lake Creek (5.8% of number supplemented in 1994). In addition, 3,794 age 1+ hatchery-produced smolts, released in Redfish Lake Creek downstream of the weir, contributed to the 1995 outmigration.

In 1996, an estimated 11,836 hatchery-produced outmigrants (14.2% of number supplemented in 1995) passed the Redfish Lake Creek outlet weir. An additional 11,545 yearling smolts were released directly to Redfish Lake Creek in 1996. We estimated 1996 outmigration from Pettit Lake at approximately 3,000 fish (34.2% of number supplemented in 1995). Therefore, total 1996 Stanley Basin sockeye salmon smolt outmigration amounted to approximately 26,381 fish.

In 1997, we estimated that approximately 400 hatchery-produced, yearling smolts outmigrated from Redfish Lake (20.7% of number supplemented in 1996). As no pre-smolts were planted in Pettit Lake in 1996, no 1997 outmigration was detected. In addition, no yearling smolts were planted to outlet streams in 1997.

In 1998, we estimated that 28,435 of the 153,022 pre-smolts planted in Redfish Lake in 1997 (18.6%) successfully overwintered and outmigrated as yearlings. Of the 94,746 pre-smolts planted in Alturas Lake in 1997, approximately 30,000 outmigrated as smolts in 1998 (31.7%). Pettit Lake yearling outmigration was estimated at approximately 100 fish (1.1% of number supplemented in 1997). Yearling smolt supplementation to Stanley Basin waters totaled 81,615 fish bringing the total 1998 estimated outmigration to approximately 140,150 fish. In addition, we detected an estimated 3,000 unmarked yearling smolts at the Redfish Lake Creek weir. As indicated above, the majority of this component were presumably produced from 1996 broodstock eyed-egg plants and 1998 pre-spawn adult releases.

Resident *O. nerka* Population Investigations

Fishery and habitat investigations conducted by the Shoshone-Bannock Tribes (BPA Project 9107100) and midwater trawl-based *O. nerka* population estimates developed by IDFG sockeye program research biologists form the foundation for the development of annual supplementation plans. IDFG trawl surveys of Stanley Basin lakes have been conducted since 1990. September estimates of total *O. nerka* population and density in Redfish Lake have increased by over two-fold since 1990. Total September population and density increased from 24,431 fish and 39.7 fish/hectare in 1990 to 55,762 fish and 90.7 fish/hectare in 1997. In 1998, Redfish Lake total O. nerka abundance and density fell to 31,486 fish and 51.2 fish/hectare. Alturas Lake has exhibited more variability with respect to *O. nerka* population parameter estimates than any other Stanley Basin lake. Since the inception of Alturas Lake trawl-based population estimates in 1990, population and density estimates have varied greater than twenty-fold. September population and density estimates have ranged from a high of 126,045 fish and 374.7 fish/hectare in 1990 to a low of 5,785 fish and 17.1 fish/hectare in 1994. Fish population numbers, and lake nutrient and food resources are rebuilding slowly in Alturas Lake. In 1998, Alturas Lake total O. nerka abundance and density was estimated at 65,468 fish and 193.7 fish/hectare. Estimated Pettit Lake *O. nerka* population and density climbed from a low of 3,009 fish and 18.8 fish/hectare in 1992 to a high of 71,654 fish and 447.8 fish/hectare in 1996. In 1997, estimated fish abundance and density dropped to 21,730 fish and 135.8 fish/hectare. In 1998, abundance and density climbed to 27,654 fish and 240.5 fish/hectare, respectively.

Environmental Life History Investigations

Using otolith microchemistry, IDFG has conducted parental lineage to discriminate individual fish from female parents with known and unknown life history since 1991. Kokanee and Redfish Lake residual sockeye salmon have been directly linked to fresh water female parents. In addition, we have demonstrated that Redfish Lake residual sockeye salmon can be fostered by anadromous female parents. Microchemistry analyses of otoliths form Redfish Lake anadromous sockeye salmon have shown that 3 of the 15 adult sockeye that returned since 1991 were produced by fresh water, residual female parents. In conjunction with genetic analyses of outmigrant sockeye incorporated into the program between 1991 and 1993, otolith microchemistry was used to help discern known anadromous outmigrants from resident kokanee drop-outs.

Redfish Lake Kokanee Management

The Redfish Lake kokanee fishery was closed to harvest in 1993 to protect residual sockeye salmon. In 1995, IDFG (with permission from NMFS) re-opened the kokanee sport fishery (recommended by the SBSTOC), as a tool to reduce intra-specific competition from resident kokanee. IDFG has monitored the fishery since its re-opening. To date, anglers have harvested an estimated 5,740 kokanee.

e. Proposal objectives

Objective 1. Develop captive broodstocks from Redfish Lake anadromous, outmigrant, and residual sockeye salmon.
Ho_1: Captive broodstocks can produce pre-spawning adults and gametes in sufficient numbers and with sufficient gamete quality to meet program needs.
$H1_1$: Maturation, reproductive success, and gamete quality in captive broodstocks will be insufficient and fail to meet program needs.
Ho_2: Cryopreserved milt can be used to develop specific lineage progeny for safety net purposes.
$H1_2$: Cryopreserved milt will yield insufficient fertilization success to meet program needs.
Products: Annual production of limited safety net broodstocks to preserve future spawning options. Safety net broodstocks will be divided between NMFS and IDFG rearing facilities to spread risk. Annual production of approximately 200,000 eyed-eggs to meet SBSTOC-identified supplementation goals for a three-lake effort. Cryopreserved milt archive maintained at three locations.

Objective 2. Determine the contribution hatchery-produced sockeye salmon make toward recovery.
Ho: Outmigration success of supplementation progeny will not differ significantly by broodstock lineage or release strategy.
H1: Outmigration success of supplementation progeny will differ significantly by broodstock lineage or release strategy.
Products: Annual estimates of smolt outmigration by broodstock lineage and release strategy. Generation of data to support SBSTOC adaptive modifications to broodstock development (by lineage) and to annual supplementation plans (by release strategy).

Objective 3. Describe *O. nerka* population characteristics for Stanley Basin lakes in relation to carrying capacity and broodstock program supplementation efforts.
Ho: Annual supplementation plans will not negatively impact critical nursery lake environments.
H1: Annual supplementation plans will negatively impact critical nursery lake environments.
Products: Annual estimates of *O. nerka* population abundance, density, and biomass for four Stanley Basin lakes. Annual development of carrying capacity guidelines produced cooperatively with the Shoshone-Bannock Tribes. Adoption of annual supplementation

plans developed at the SBSTOC level following a thorough review of : 1) the availability of supplementation eggs, progeny, and pre-spawn adults, 2) "background" *O. nerka* population characteristics, and 3) annual carrying capacity guidelines.

Objective 4. Refine our ability to discern the origin of wild and broodstock *O. nerka* to provide maximum effectiveness in their utilization within the broodstock program.

Ho: Otolith microchemistry can be used to identify environmental life history of wild and broodstock *O. nerka*.

H1: Otolith microchemistry is not discriminatory enough to identify environmental "finger prints" among life history types.

Products: Base-line environmental life history information for *O. nerka* of known and unknown origin.

Objective 5. Technology Transfer.

Products: Participation in the Technical Oversight Committee process. Preparation of annual reports to satisfy NMFS permit requirements under the Endangered Species Act. Preparation of annual reports to satisfy BPA contract requirements. Presentation of program information at technical meetings.

f. Methods

Objective 1. Fish culture methods used in the captive broodstock program follow accepted, standard practices (for an overview of standard methods see Leitritz and Lewis 1976; Piper et al. 1982; Erdahl 1994; Bromage and Roberts 1995; McDaniel et al. 1996; Pennell and Barton 1996). Considerable coordination takes place between NMFS and IDFG culture experts and at the SBSTOC level. Spawning has occurred at Eagle Fish Hatchery each year since the inception of the program in 1991 (Johnson 1992; Johnson 1993; Johnson and Pravecek 1995, 1996; Pravecek and Johnson 1997). The IDFG is required by NMFS Permit 1120 to discuss proposed broodstock spawning matrices prior to conducting activities. Eggs produced at spawning are divided into several lots (by female) and fertilized with sperm from multiple males. Eggs are incubated by lot at different water temperatures to yield lineage-specific size groups for supplementation under different strategies and for future broodstock purposes. Cryopreservation of milt from male donors has been used in the captive broodstock program since 1991 and follows techniques described by Cloud et al. (1990) and Wheeler and Thorgaard (1991). Beginning in 1996, cryopreserved milt was used to produce specific lineage broodstocks for use in future spawn years. "Designer broodstocks", produced in this manner, will increase the genetic variability available in future brood years. Critical linkages exist between IDFG and NMFS with respect to the sharing of fish culture responsibilities. Linkages also exist between IDFG, the University of Idaho, and NMFS with respect to genetic monitoring of wild and captive *O. nerka*.

Objective 2. Progeny produced at Eagle Fish Hatchery and at NMFS facilities are supplemented to Stanley Basin waters at different life history stages using a variety of release options including: 1) eyed-egg releases to lake incubator boxes, 2) pre-smolt releases direct to lakes, 3) pre-smolt releases to Redfish Lake following net pen rearing, 4) smolt releases to outlet streams and to the upper Salmon River, and 5) pre-spawn adult releases direct to lakes (Kline 1994; Kline and Younk 1995; Kline and Lamansky 1997).

Outmigrant evaluations are designed to determine whether broodstock lineage or release strategy are critical to the outmigration success of supplementation progeny released to Stanley Basin nursery waters. Adaptively managed, experimental results are incorporated into annual supplementation plans to guide future release plans and ultimately improve program success. The SBSTOC plays a major role in the development of an annual, prioritized release plan. To estimate *O. nerka* outmigrant run size from Redfish, Alturas and Pettit lakes, IDFG personnel operate smolt traps on Redfish Lake Creek and on the upper Salmon River at the IDFG Sawtooth Fish Hatchery.

Wild outmigrant sockeye salmon captured at Redfish Lake Creek and Sawtooth FH trap sites are anesthetized in buffered MS222 (Methane Tricaine Sulfonate), measured for fork length, weighed (Redfish Lake Creek only), and injected with PIT tags. Hatchery outmigrants (identified by the absence of adipose fins) captured at the Redfish Lake Creek trap site are anesthetized in this same manner and scanned for PIT tags. PIT-tagged hatchery outmigrants are measured for fork length and weighed as for wild outmigrants. Non-PIT-tagged hatchery outmigrants are enumerated but are not PIT-tagged. All captured sockeye salmon outmigrants are held in flow-through, low velocity live boxes at their respective trap sites and released approximately one-half hour after sunset.

Trapping efficiency is determined by releasing PIT-tagged wild outmigrants upstream for subsequent recapture. Total emigration or outmigration run size is estimated by summing the products of trap efficiency and daily trap catch for specific intervals within the total period of outmigration. Intervals are defined as periods of outmigration with similar stream discharge and recapture efficiency. The variance around trapping efficiency periods is determined using methods for proportional data described in Fleiss (1981).

We evaluate outmigration success by broodstock program release strategy at the Redfish Lake Creek trap, the Pettit Lake Creek trap, and at lower Snake and Columbia river dams with fish bypass and PIT tag detection facilities (Lower Granite, Little Goose, Lower Monumental, and McNary dams). PIT tag interrogation data for mainstem Snake and Columbia river dams is retrieved from the Columbia River Basin PIT Tag Information System (PTAGIS). Median travel times to Lower Granite Dam are calculated (where possible) for wild and hatchery-produced sockeye salmon. Because systems operations and fish handling potentially differ by date, arrival times to Lower Granite Dam are compared for wild and hatchery-produced progeny (by release strategy) using two sample Kolmogorov-Smirnov tests (a=.05), (Sokal and Rohlf 1981). Multiple, chi-square goodness of fit tests are used to compare PIT tag interrogation data for both the Redfish Lake trap and mainstem dam locations (Zar 1974). A priori power analysis for chi-square tests is conducted to determine PIT tag sample size (Cohen 1989). By establishing hypothetical over-winter survival rates and outmigration estimates and by applying a minimum estimate of cumulative, unique interrogation at mainstem Columbia and Snake river dams, we were able to develop an estimate of the number of PIT tag detections we should see for any one release lineage or release strategy. This allows us to establish a series of hypothetical detection proportions between test groups and compute different effect sizes to determine the total number of unique dam detections required to yield 0.80 power at the 0.05 significance level. Critical linkages exist with downstream

PIT tag interrogation and data base programs and with limnology investigations and whole lake fertilization programs conducted by the Shoshone-Bannock Tribes.

Adult sockeye salmon released to Stanley Basin lakes for volitional spawning are tracked using ultrasonic telemetry equipment to document movement patterns and identify spawning-related behavior. Telemetry investigations also allow us to identify the incidence of over winter survival for adults released the previous year.

To provide information on the potential impact of harvest-oriented sport fisheries in sockeye salmon nursery lakes, we conduct roving creel surveys on Redfish and Pettit lakes (Kline and Lamansky 1997). Creel surveys are stratified by 14 day interval, weekday and weekend day types, and morning (06:00 to 16:00) and evening (16:00 to 20:00) day periods. Two weekday and one weekend day are surveyed each week of the census. On each survey date, two instantaneous counts are made (one in each day period). We select angler count dates randomly and count times systematically. Adipose fins are removed from all creeled kokanee and stored in 70% ethanol for mitochondrial DNA analysis by University of Idaho personnel. Hatchery rainbow trout (Pettit Lake only) fin marks are identified to document over winter survival. Creel data are analyzed using the Creel Census System program developed by McArthur (1992).

<u>Objective 3</u>. To estimate *O. nerka* population, density, and biomass, we conduct midwater trawling at night during the dark (new) phase of the moon. Trawling is performed in a stepped-oblique fashion as described by Rieman (1992) and Kline (1994). We estimate total *O. nerka* population, density, and biomass using the TRAWL.WK1 developed by Rieman (1992). Population, density, and biomass estimates generated by this program are extrapolations of actual trawl catch data to the total area of the lake mid-depth in the observed sockeye salmon stratum. Whenever possible, we estimated population and density by individual age-class (assuming representation in the trawl).

We record fork length and weight for all trawl-captured *O. nerka*. Sagittal otoliths are removed from all fish, cleaned, and stored dry in microcentrifuge tubes. All otoliths are surface-aged otoliths under transmitted and/or reflected light with the aid of a variable power dissecting microscope. Tissue samples are collected and preserved for genetic analysis by NMFS and University of Idaho technicians. Stomachs are removed and preserved for diet analysis by Shoshone- Bannock Tribe biologists (Kline 1994; Kline and Younk 1995; Kline and Lamansky 1997). Midwater trawl-based population estimates are used to develop annual supplementation plans.

<u>Objective 4</u>. We use otolith microchemistry to improve our knowledge of the parental lineage of wild and broodstock sockeye salmon and kokanee. The preparation of otoliths for microchemistry analysis follows procedures developed by Kalish (1990) and Rieman et al. (1993). Sample preparations are analyzed at Oregon State University (College of Oceanography, Corvallis, OR 97331-5503) and follow procedures outlined by Toole and Nielsen (1992). Microprobe transects are run in otolith nuclei adjacent to the primordia of all samples (Kline 1994; Kline and Younk 1995; Kline and Lamansky 1996).

g. Facilities and equipment

Eagle Fish Hatchery is the primary Idaho site for the sockeye captive broodstock program. Artesian water from five wells is currently in use. Artesian flow is augmented through the use of four separate pump/motor systems. Water temperature remains a constant 13.3^{o}C and total dissolved gas averages 100% after degassing. Water chilling capability was added at Eagle Hatchery in 1994. Chiller capacity accommodates egg incubation, fry rearing, and a portion of adult holding needs. Backup and system redundancy is in place for degassing, pumping, and power generation. Nine water level alarms are in use and linked through an emergency service operator. Additional security is provided by limiting public access and by the presence of three on-site residences occupied by IDFG hatchery personnel.

Facility layout at Eagle Hatchery remains flexible to accommodate culture activities ranging from spawning and incubation through adult rearing. Egg incubation capacity at Eagle Hatchery is approximately 180,000 eggs. Incubation is accomplished in small containers specifically designed for the program. Incubators are designed to distribute both up welling and down welling flow to accommodate pre and post-hatch stages.

Several fiberglass tank sizes are used to culture sockeye from fry to the adult stage including: 1) 0.7 m diameter semi-square tanks (0.91 m^3), 2) 1 m diameter semi-square tanks (0.30 m^3), 3) 2 m diameter semi-square tanks (1.42 m^3), 4) 3 m diameter circular tanks (6.50 m^3), and 5) 4 m diameter semi-square tanks (8.89 m^3). Typically, 0.7 m and 1 m tanks are used for rearing fry from ponding to approximately 1 g weight. Two and three meter tanks are used to rear juveniles to approximately 10 g and to depot and group fish by lineage or release strategy prior to distribution to Stanley Basin waters. Three and four meter tanks are used to rear fish to maturity for future broodstock production (spawning). Flows to all tanks are maintained at no less than 1.5 exchanges per hour. Shade covering (70%) and jump screens are used where appropriate. Discharge standpipes are external on all tanks and assembled in two sections (“half pipe principal”) to prevent tank dewatering during fish sampling and tank maintenance periods.

Sawtooth Hatchery was completed in 1985 as part of the Lower Snake River Compensation Plan and is located on the Salmon river 3.5 km upstream from the confluence of Redfish Lake Creek. Sawtooth Hatchery personnel and facilities have been used continuously since 1991 for various aspects of the sockeye captive broodstock program including: 1) pre-spawn anadromous adult holding, 2) egg incubation, and 3) juvenile rearing for pre-smolt and smolt releases. In addition, hatchery personnel assist with many field activities including: 1) net pen fish rearing, 2) fish trapping and handling, and 3) fish transportation and release.

Eyed-eggs, received at Sawtooth Hatchery from Eagle Hatchery or NMFS facilities, are incubated in Heath trays. Fry are ponded to 0.7 m fiberglass tanks as described above. Juvenile sockeye (>1 g) are held in vats or in a series of 2 m fiberglass tanks installed in 1997. Typically, juvenile sockeye salmon reared at Sawtooth Hatchery are released as sub-yearlings or yearlings. Pre-spawn anadromous adults captured at Redfish Lake Creek or Sawtooth Hatchery weirs are held in vats until their transfer to the Eagle Hatchery for spawning. All incubation, rearing and holding occurs on well water. Water temperature varies by time of year from approximately 2.5 ^{o}C in January/February to 11.1 ^{o}C in August/September. Back-up and redundancy systems are in place. Rearing protocols are established cooperatively between IDFG personnel and reviewed at the SBSTOC level.

Containers used to transport fish vary by task. In all cases, containers of the proper size and configuration are used for the task at hand. Fish are maintained in water of the proper quality (temperature, oxygen, chemical composition) as much as is possible during handling and transfer phases of transportation. Containers vary from five-gallon plastic buckets and coolers for short term holding and inventory needs to very sophisticated truck-mounted tanks for long distance (or duration) transfers. Truck mounted tanks with capacities of 300 gal. (1,136 L), 1000 gal. (3,785 L), and 2,500 gal. (9,463 L) are available to the program.

Monitoring and evaluation equipment includes; a trawl boat used for lake population investigations, two skiffs used for net pen, egg release, and telemetry surveys, a permanent weir footing and associated equipment used for outmigrant and adult trapping on Redfish Lake Creek, one PIT tag station and several back-up readers and antennas, one camp trailer for field personnel, telemetry tracking gear, cryopreservation equipment, SCUBA equipment used for net pen maintenance, and many other miscellaneous pieces of equipment necessary for completion of identified tasks. Computer equipment includes two desktop units and five laptop units for office and field activities (laptops used primarily for PIT tagging). Four vehicles are assigned to the project with additional IDFG vehicles available as needed (fish transportation). Immediate project personnel are located at two locations; the Eagle Fish Hatchery and the Nampa Fisheries Research Office. Adequate office and storage space is available.

The IDFG Fish Health Laboratory is located adjacent to the Eagle Fish Hatchery and provides space for all necropsy work associated with the program. Pathology investigations are carried out, as needed, at this location.

h. Budget

Personnel ($218,900) - Personnel gross salaries distributed as follows:
Full time FTE - Principal Investigator.
Full time FTE - Assistant Hatchery Manager
Full time FTE - Fish Culturist
Full time FTE - Research Biologist
2-months of full time FTE – Fish Pathologist
32 hours of technician / bioaide time allocated to fish culture responsibilities
16 hours of technician / bioaide time allocated to research responsibilities.

Fringe Benefits ($74,800) – Employee benefits on above gross salaries.

Supplies and Materials and non-expendable materials ($62,500)
Repair and Maintenance supplies – vehicle supplies, boat and motor supplies, building supplies, equipment repair and maintenance supplies.
Institutional and Residential supplies – office, residential, and janitorial supplies.
Specific use supplies – energy supplies, plumbing supplies, building materials, tools, field equipment, fish feed, software, computer equipment, general hatchery supplies.

Operation and Maintenance ($120,183) –

Communication services, employee development services, other services, professional services, repair and maintenance services, administrative services, utility services, vehicle lease and rental. Note – electric utility costs associated with water chiller, well pumps, motors, and generators represents a significant portion of this category.

Capital ($60,000) – Fiscal year 2000 projected capital needs include:
Replacement fish transportation vehicle
Raceway modification (site work)
Asphalt seal coat (site work)
Backup well pump and motor
Replacement boat motor.

Travel ($17,250) – All costs associated with the following:
Air faire - travel for principal investigator, pathologist, and research biologist to technical meetings, program management meetings, and related process meetings.
Lodging - All in-state and out-of-state lodging for with field activities and meetings.
Ground transportation – Rental vehicles for out-of-state travel.
Per-diem - all meal costs for all project personnel while away from duty station.

Indirect Costs ($109,063) –
State of Idaho overhead costs applied to all budget categories except capital outlay.

Section 9. Key personnel

The project Principal Investigator is Paul Kline. Mr. Kline has worked for IDFG since 1992 in resident and anadromous fisheries research sub-sections. He has been affiliated with sockeye salmon recovery efforts since 1993. Prior to assuming the position of principal investigator, Mr. Kline served as sockeye project Research Biologist. In this capacity, he coordinated all evaluation activities associated with *O. nerka* population monitoring in Basin lakes, juvenile outmigrant monitoring, pre-spawn adult volitional spawning investigations, life history investigations, and kokanee fishery monitoring. He received his B.S. and M.S. in Natural Resources and Fisheries from Humboldt State University (1975, 1980). Prior to coming to IDFG, Mr. Kline worked for the United States Forest Service and for a private consulting firm in Northern California. During his years in the consulting business, Mr. Kline was lead investigator on numerous fishery habitat and population surveys of coastal salmon and steelhead systems. In his present capacity, Mr. Kline oversees all sockeye salmon activities for IDFG in addition to managing all hatchery activities associated with IDFG's spring chinook salmon captive rearing project.

Keith Johnson serves as fish pathologist and technical advisor for the sockeye program. Dr. Johnson received his B.S. (1966) from the University of Idaho, his M. S. (1968) from Montana State University and his Ph.D from Oregon Stete University (1975). Dr. Johnson has worked in fish culture and fish health for 24 years. Dr. Johnson is currently Fish Health Manager for IDFG. Prior to assuming this position, Dr. Johnson served as principal investigator on the Sockeye Captive Broodstock Program.

The Research Biologist on the project is Jay Pravecek. Mr. Pravecek has worked for IDFG within the sockeye program since 1994. Prior to assuming the Research Biologist position in 1997, he served as Fish Culturist on the project. As Culturist, Mr. Pravecek was responsible for the care and keeping of sockeye captive broodstocks at the IDFG Eagle Fish Hatchery. He received his B.S. in Biology from Black Hills State University in 1991 and his M.S. in Fish and Wildlife Management from Montana State University in 1995. Prior to coming to IDFG, Mr. Pravecek worked for South Dakota Game, Fish, and Parks, U.S Fish and Wildlife Service, and Montana State University. Work conducted before coming to IDFG involved fish culture and fisheries research.

Brian Malaise holds the position of Assistant Hatchery Manager at the IDFG Eagle Fish Hatchery. Mr. Malaise has worked for IDFG since 1990 at several resident and anadromous state facilities. He has been associated with the sockeye program since 1996. Mr. Malaise received his B.S. in Fisheries and Wildlife Biology from Iowa State University in 1990. Prior to coming to IDFG, Mr. Malaise worked for the Iowa Department of Natural Resources.

Jeff Heindel holds the position of Fish Culturist at the IDFG Eagle Fish Hatchery. Mr. Heindel has worked for IDFG since 1991. During his seven years with IDFG, Mr. Heindel has worked at Steelhead and Chinook hatcheries as well as the State's most productive resident trout facility. He has been associated with the sockeye program since 1996. Mr. Heindel received his B.S. degree from Boise State University in 1995.

Section 10. Information/technology transfer

Considerable local attention is drawn to project activities in the Stanley Basin of Idaho. Project cooperators strive to maintain an up-to-date awareness at this local level. IDFG Sawtooth Hatchery personnel, Salmon Region personnel, and immediate project personnel make public contacts on a regular basis to discuss project-related issues. IDFG information and education and enforcement personnel address different audiences several times each year to distribute project-related information. Idaho and regional news media interview project cooperators frequently contributing to the publics' awareness of regional salmon issues.

Project cooperators meet monthly (SBSTOC) to discuss findings and review planned activities. BPA chairs this process and develops concise meeting minutes that are available to the public. Annual reports of program activities a written and are available from the BPA library. Annual reports of program activities required by Section 10 of the Endangered Species Act are also prepared. Presentations are made at regional fish culture and fish health conferences and at meetings held by the Idaho Chapter of the American Fisheries Society.

Congratulations!